Unit 01

PHYSICAL QUANTITIES AND MEASUREMENT

Introduction

In this chapter we will learn about the measurement of length, mass, time and volume in daily life activities using various measuring instruments and brief description about the various branches of physics.

Q1. Define science.

Ans. "The knowledge gained through observations and experimentations is called Science."

The word science is derived from the Latin word "**Scientia**" which means knowledge. "Various aspects of material objects were studied under a single subject called natural philosophy". But as the knowledge increased, it was divided into **Physical sciences** – which deal with the study of non-living things and **Biological sciences** which are concerned with the study of living things.

Q2. Define physics and explain its branches.

Ans. ''The branch of science which deals with the study of matter, energy and their interaction. The laws and principles of Physics help us to understand the nature''

BRANCHES OF PHYSICS

i. Mechanics

It is the study of motion of objects, its causes and effects, which influence motion.

ii. Heat

It deals with the nature of heat, modes of transfer and effects of heat.

iii. Sound

It deals with the physical aspects of sound waves, their production, properties and applications.

iv. Light (Optics)

It is the study of physical aspects of light, its properties, working and use of optical instruments.

v. Electricity and Magnetism

It is the study of the charges at rest and in motion, their effects and their relationship with magnetism.

vi. Atomic Physics

It is the study of the structure and properties of atoms.

vii. Plasma Physics

It is the study of production, properties of the ionic state of matter – the fourth state of matter.

viii. Geophysics

It is the study of the internal structure of the Earth.

ix. Nuclear Physics

It deals with the properties and behaviour of nuclei and the particles within the nuclei.

Q3. Write the importance of physics in our daily life?

Ans. In our daily life, we hardly find a device where physics is not using.

i. The pulleys that make easy to lift heavy loads.

ii. Electricity is used not only to get light and heat but also mechanical energy that drives fans and electric motors etc.

iii. The means of transportation such as car and aeroplanes; domestic appliances such as air-conditioners, refrigerators, vacuum cleaners, washing machines, and microwave ovens etc are using the rules of Physics.

iv. The means of communication such as radio, TV, telephone and computer are the result of applications of Physics. These devices have made our lives much easier, faster and more comfortable than the past.

For example, mobile phone, Telephone, Fax Machine, Telex Machine and Internet etc.

Q4. Define physical quantities. Also write its types.

Ans: PHYSICAL QUANTITIES

Those quantities which can be measured are called **physical quantities.**

For example: length, mass, time and temperature etc.

A physical quantity possesses at least two characteristics. One is its numerical value and the other is the unit in which it is measured. For example, if the length of a student is 104 cm then 104 is its numerical value and centimeter is the unit of measurement. Physical quantities are divided into two quantities

(i) Base quantities and (ii) Derived quantities.

i. BASE QUANTITIES

"There are seven physical quantities which **form** the basis of other physical quantities. These physical quantities are called the base quantities".

For example: length, mass, time, electric current, temperature, intensity of light and the amount of a substance.

ii. DERIVED QUANTITIES

"Those physical quantities which are expressed in terms of base quantities are called the derived quantities".

For example: area, volume, speed, force, work, energy, power, electric charge, electric potential, etc.

Q5. What is international system of units? OR What role SI Units have played in the development of Science?

Ans. With the developments in the field of science and technology, the need for a commonly acceptable system of units was seriously felt all over the world particularly to exchange scientific and technical information. The eleventh General Conference on Weight and Measures was held in Paris in 1960 adopted a world-wide system of measurements called

International System of Units. The International System of Units is commonly named as **SI.**

Q6. What are base units and derived units?

Ans. i. BASE UNITS

The units that describe base quantities are called base units. Each base quantity has its SI unit.

Base quantities, their SI units with symbols			
Quantity		**Unit**	
Name	Symbol	Name	Symbol
Length	ℓ	Metre	m
Mass	m	Kilogramme	kg
Time	t	Second	s
Electric current	I	ampere	A
Intensity of light	L	candela	Cd
Temperature	T	kelvin	k
Amount of a substance	n	mole	mol

ii. DERIVED UNITS

"**The units used to measure derived quantities are called derived units**". These are derived in terms of base units and are obtained by multiplying or dividing one or more base units with each other.

For example the unit of area $(\text{metre})^2$ and the unit of volume $(\text{metre})^3$ are based on the unit of length, which is metre. Thus the unit of length is the base unit while the unit of area and volume are derived units. Speed is defined as distance covered in unit time; therefore its unit is metre per second. Some derived units and their symbols are given below

Quantity		**Unit**	
Name	Symbol	Name	Symbol
Speed	v	metre per second	ms^{-1}
Acceleration	a	metre per second per second	ms^{-2}
Volume	V	cubic metre	m^3
Force	F	Newton	N or $(kg\ m\ s^{-2})$
Pressure	P	Pascal	Pa or $(N\ m^{-2})$
Density	ρ	kilogramme per cubic metre	$Kg\ m^{-3}$
Charge	Q	Coulomb	C or (As)

Q7. Define prefixes and give example?

Ans. "The words or letters added before units and stand for multiples and sub multiples of that unit are known as prefixes". For example kilo, mega, giga etc. The prefixes are useful to express very large or small quantities.

For example, divide 20,000 g by 1000 to express it into kilogramme, since kilo represents 10^3 or 1000.

Thus $20{,}000\ g = \frac{20{,}000}{1000} kg = 20kg$

Or $20{,}000\ g = 20 \times 10^3\ g = 20kg$

Q8. Define Scientific Notation and give example

Ans. "In scientific notation a number is expressed as some power of ten multiplied by a number between 1 and 10".

For example, a number 62750 can be expressed as 6.275×10^4 preferably be taken as the standard form. Similarly the standard form of 0.00045 s is 4.5×10^{-4}s.

Q9. What are measuring instruments? Explain meter rule and measuring tape.

Ans. Measuring instruments are used to measure various physical quantities such as length, mass, time, volume, etc.

THE METRE RULE

"A metre rule is a length measuring instrument as shown in figure. It is commonly used in the daily life to measure length of an object or distance between two points".

Construction: It is one metre long and have 100 centimetres. Each big division (cm) is divided into 10 small divisions called millimetre (mm). Thus one millimetre is the smallest reading that can be taken using a metre rule and is called its least count.

A metre rule

Note:

While measuring length, or distance, eye must be kept vertically above the reading point. The reading becomes doubtful if the eye is positioned either left or right to the reading scale.

i. THE MEASURING TAPE

"Measuring tapes are used to measure length in metres and centimetres. A measuring tape is used by blacksmith and carpenters".

Construction: A measuring tape consists of a thin and long strip of cotton, metal or plastic generally 10 m, 20 m, 50 m or 100 m long. Measuring tapes are marked in centimetres as well as in inches.

Q10. What is meant by vernier callipers? Write its construction.

Ans. The accuracy obtained in measurements using a metre rule is upto 1 mm. However an accuracy greater than 1 mm can be obtained by using some instrument called vernier callipers.

"It is an instrument which is used to measure the 10^{th} part of mm".

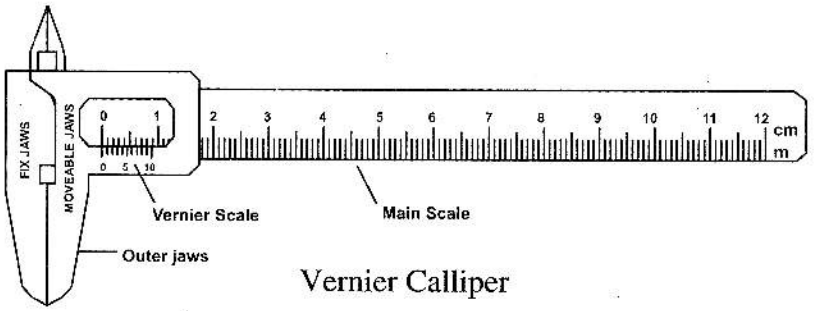
Construction

A Vernier Callipers consists of two jaws. One is a fixed jaw with main scale. It has marks centimetre and millimetre. The other jaw is a moveable jaw having vernier scale having 10 divisions and each of its division is 0.9 mm.

Vernier Constant:

The difference between one small division on main scale division and one vernier scale division is 0.1 mm and called vernier constant.

Least count (LC) of the Vernier Callipers. Least count of the Vernier Callipers can also be found as given below:



Vernier Calliper

$$\text{Least count of vernier calliper} = \frac{\text{smallest reading on main scale}}{\text{no. of divisions on vernier scale}}$$

$$\frac{1\text{mm}}{10} = 0.1\text{mm}$$

Hence L.C = 0.1 mm = 0.01 cm

Working of a Vernier Callipers

First of all find the zero error, in the measuring instrument.

Zero Error and Zero Correction

To find the zero error, close the jaws of Vernier Callipers. If zero of the vernier scale coincides with the zero of the main scale then there is no zero error in the instrument.

Zero Error

Zero error will exist if zero of the vernier scale is not coinciding with the zero of main scale. There are two types of errors.

i. Positive Zero Error

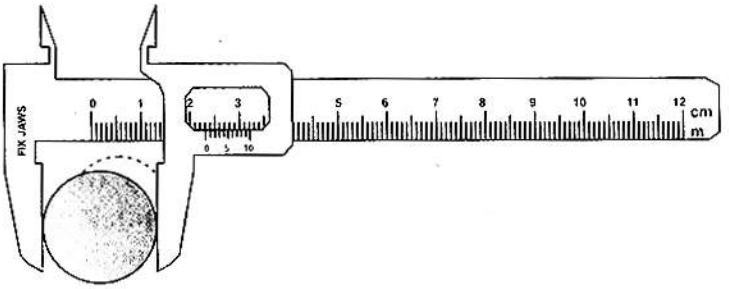
Zero error will be positive if zero of vernier scale is on the right side of the zero of the main scale.

ii. Negative Zero Error

If zero line of vernier scale is on the left side of zero of the main scale then zero error will be negative.

Q11. How we can take reading on Vernier Callipers? (Practical)

Ans. To find the diameter of a solid cylinder using Vernier Callipers. Place the solid cylinder between jaws of the Vernier Callipers. Close the jaws.



Now find the complete divisions of main scale before the vernier scale zero now note the vernier scale division that is coinciding with any division on the main scale. Multiply it by least count of Vernier Callipers in cm and add it in the main scale reading. This is equal to the diameter of the solid cylinder. Add zero correction if any (Z.C) to get correct measurement.

Example 1.1

Find the diameter of a cylinder placed between the outer jaws of Vernier Callipers as shown in figure.

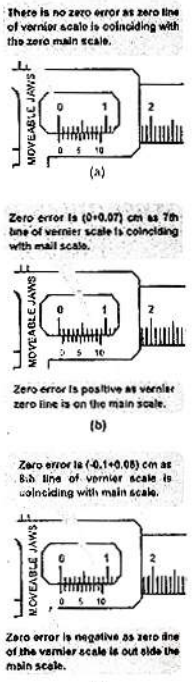

There is no zero error as zero line of vernier scale is coinciding with the zero main scale.
MOVEABLE JAWS
(a)
Zero error is (0+0.07) cm as 7th line of vernier scale is coinciding with mail scale.
MOVEABLE JAWS
Zero error is positive as vernier zero line is on the main scale.
(b)
Zero error is (-0.1+0.08) cm as 8th line of vernier scale is coinciding with main scale.
MOVEABLE JAWS
Zero error is negative as zero line of the vernier scale is out side the main scale.
(c)

Figure 1.7: Zero Error

Solution:

Zero correction

On closing the jaws of Vernier Callipers, the position of vernier scale as shown in figure.

Main scale reading = 0.0 cm

Vernier division coinciding with main scale = 7 div.

Vernier scale reading = 7×0.01 cm

= 0.07 cm

Zero error = 0.0 cm + 0.07 cm

= + 0.07 cm

Zero correction (Z.C) = –0.07 cm

Diameter of the cylinder

Mains scale reading = 2.2cm

(When the given cylinder is kept between the jaws of the Vernier Callipers as shown in figure.)

Vernier div. coinciding with main scale div. = 6 div.

Vernier scale reading = 6×0.01 cm

= 0.06 cm

Observed diameter of the cylinder = 2.2 cm + 0.06 cm

= 2.26 cm

Correct diameter of the cylinder = 2.26 cm – 0.07 cm

= 2.19cm

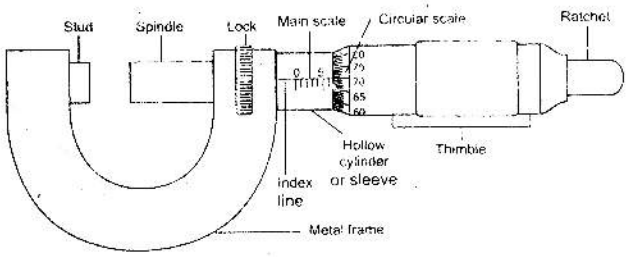
Thus, the correct diameter of the given cylinder as found by Vernier Callipers is 2.19 cm.

Q12. Define "SCREW GAUGE" and write its construction.

Ans. "A screw gauge is an instrument that is used to measure small lengths with accuracy greater than a Vernier Calliper." It is an instrument which is used to measure 100 part of mm. It is also called as micrometer screw gauge.

Construction

A simple screw gauge consists of a U-shaped metal frame with a metal stud at its one end hollow cylinder (or sleeve) has a millimetre scale over it along a line called index line. The hollow cylinder acts as a nut. It is fixed at one end. A Thimble which has a threaded spindle inside it.



Micrometer screw gauge

Pitch: The thimble completes one rotation, hundred division spindle moves 1 mm distance. This distance is called the pitch of screw gauge.

As thimble completes one rotation, 100 divisions pass the index line the thimble moves 1 mm along the main scale. Thus each division of circular scale crossing the index line moves the thimble through 1/100 mm or 0.01 mm on the main scale. Least count of a screw gauge can be calculated as:

$$\text{Least count} = \frac{\text{pitch of the screw gauge}}{\text{no. of divisions on circular scale}}$$

$$= \frac{1\text{mm}}{100}$$

$$= 0.01 \text{ mm} = 0.001 \text{ cm}$$

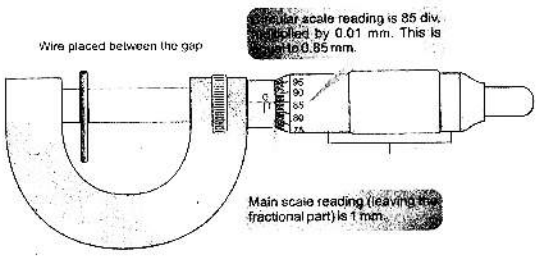
Q13. How does screw Gauge work? (Practical)

Ans. Working of a Screw Gauge:

First step is to find the zero error of the screw gauge.

ZERO ERROR

To find the zero error, close the gap between the spindle and the stud by rotating the ratchet in the clockwise direction. If zero of circular scale coincides with the index line, then there is no zero error in the instrument. If the zero of circular scale cross or below the index line then there is zero error. In screw gauge. There are two types of error.



Positive zero error

Zero error of instrument will be positive if zero of circular scale is behind the index line.

Negative zero error

Zero error of screw gauge will be negative if zero of circular scale has crossed the index line.

Example 1.2

Find the diameter of a wire using a screw gauge.

i. Close the gap between the spindle and the stud of the screw gauge by turning the ratchet in the clockwise direction.

ii. Note main scale as well as circular scale readings to find zero error and hence zero correction of the screw gauge.

iii. Open the gap between stud and spindle of the screw gauge by turning the ratchet in anti-clockwise direction. Place the given wire in the gap as shown in figure. Turn the ratchet so that the object is pressed gently between the studs and the spindle.

iv. Note main scale as well as circular scale readings to find the diameter of the given wire.

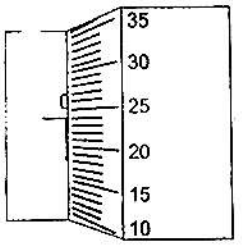
v. Apply zero correction to get the correct diameter of the wire.

vi. Repeat steps (iii), (iv) and (v) at different places of the wire to obtain its average diameter.

Zero Correction:

Closing the gap of the screw gauge.

Here main scale reading is 0 mm and 23rd division of circular scale is before the index line. Hence zero error is (0+23×0.01) mm = 0.23 mm.



Main scale reading = 0 mm

Circular scale reading = 24×0.01 mm

= 0.24 mm

Zero error of the screw gauge = 0 mm + 0.24 mm

= + 0.24 mm

Zero correction Z.C = –0.24 mm

Diameter of the wire

Main scale reading = 1mm

(When the given wire is pressed by the stud and spindle of the screw gauge)

No. of divisions on circular scale = 85 div.

Circular scale reading = 85×0.01 mm

= 0.85 mm

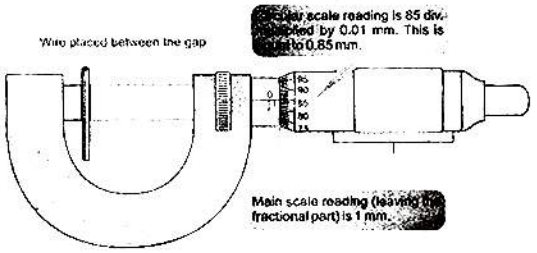
Observed diameter of the given wire = 1mm + 0.85 mm

= 1.85 mm

Correct diameter of the given wire = 1.85 mm – 0.24 mm

= 1.61 mm

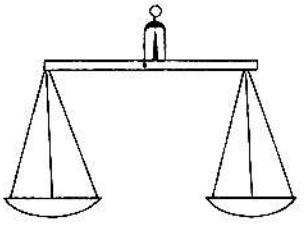
Thus diameter of the given wire is 1.61 mm


Wire placed between the gap
Circular scale reading is 85 div. multiplied by 0.01 mm. This is equal to 0.85 mm.
Main scale reading (leaving the fractional part) is 1 mm.

Measuring the diameter of a wire using a micrometer

Q14. What are mass measuring instruments?

Ans. Pots were used to measure grain in various part of the world in the ancient times. However, Balances were also in use by Greeks and Romans such as **beam balance**. In a beam balance, the unknown mass is placed in one pan and is balanced by putting known masses in the other pan. Today we use many types of mechanical and electronic balances. Such as physical balance, lever balance, Electronic Balance etc.



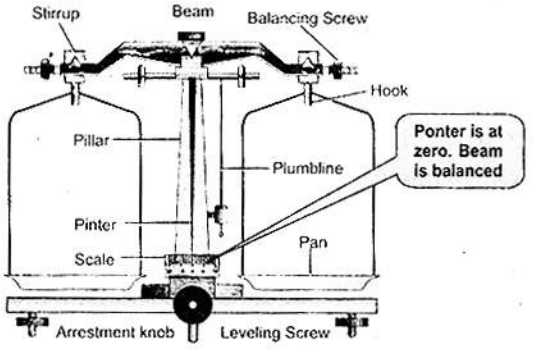
Beam Balance

Q15. What is physical balance? Write its constructions and working?

Ans. "A physical balance is used in the laboratory to measure the mass of objects".

Construction

It consists of a beam resting at the centre on a fulcrum. The beam carries pans over the hooks on either side. Unknown mass is placed on the left pan and some standard masses are placed in right pans to bring the pointer at zero position.



(i) Working:

Following steps are used to measure the mass.

i. First of all adjusting the leveling screws with the help of plumb line to level the platform of physical balance by placing it on horizontal surface.

ii. Raise the beam by turning the arresting knob clockwise. Balance the pans by screw level and bring the pointer at zero.

iii. Bring beam back on its supports by knob. Place the given object (stone) on its left pan.

iv. Place standard masses in the right pan. Raise the beam. Lower the beam if its pointer is not at zero.

v. Repeat adding or removing standard masses in the right pan till the pointer rests at zero position.

vi. Note the standard masses on the right pan. Their sum is the total mass of the object on the left pan.

(ii) LEVER BALANCE

A lever balance consists of a system of levers. When lever is lifted placing the object in one pan and standard masses on the other pan, the pointer of the lever system moves. The pointer is brought to zero by varying standard masses.

(iii) ELECTRONIC BALANCE

Electronic balances come in various ranges, milligram ranges, gram ranges and kilogramme ranges. Before measuring the mass of a body, it is switched ON and its reading is set to zero. Next place the object to be weighed. The reading on the balance gives you the mass of the body placed over it.

Q16. Show by an example which one is the most Accurate Balance?

Ans. Suppose the mass of one rupee coin is done using different balances as given below:

(a) Beam Balance

Let the mass of coin is 3.2 g by using beam balance.

A beam balance is able to detect a change as small as of 0.1 g Or 100 mg i,e the least count of beam balance is 0.1 g.

(b) Physical Balance

Let the mass of coin is 3.24g by physical balance.

Since the least count of the physical balance is 0.01 g or 10 mg. Therefore, its measurement is more precise than a sensitive beam balance.

(c) Electronic Balance

Let the mass of coin is 3.247 g by electronic balance.

Least count of an electronic balance is 0.001 g or 1 mg. Therefore, its measurement is more precise than a physical balance, so electronic balance is the most sensitive balance in the above balances.

Q17. What is meant by Stopwatch? Writes its types.

Ans. A stopwatch is used to measure the time interval of an event.

Types of stop watches

There are two types of stopwatches.

i. Mechanical stop watch

ii. Digital stop watch.

Mechanical stop watch

A mechanical stopwatch can measure a time interval up to a minimum 0.1 second. So its least count is 10^{th} part of a second.

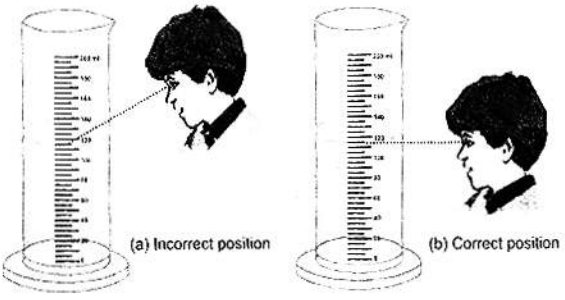
A mechanical stopwatch has a knob. It is used as a start-stop and reset button, the watch starts when the knob is pressed once. When pressed second time, it stops the watch while the third press brings the needle back to zero position.

Digital stop watch.

Digital stopwatch can measure a time interval as small as 0.01 second. So its least count is 100 part of a second.

The digital stopwatch starts to indicate the time lapsed as the start/stop button is pressed. As soon as start/stop button is pressed again, it stops and shows the time interval recorded by it between start and stop of an event. A reset button brings it to zero setting.

Q18. What is measuring cylinder? Explain.



Ans. A measuring cylinder is made of a glass or transparent plastic material. It has a scale that indicates the volume in milliliter (mL). It has different capacities from 100 mL to 2500 mL. They are used to measure the volume of a liquid or powdered substance. It can also be used to find the volume of an irregular shaped solid which is insoluble in a liquid by displacement method. The solid object is lowered into a measuring cylinder containing liquid. The level of liquid rises. The increase in the volume of liquid is the volume of the given solid object.

Q19. How can we measure the volume of an irregular shaped solid object?

Ans. Measuring cylinder can be used to find the volume of a small irregular shaped solid that sinks in water. Suppose we want to find the volume of a small stone. Take some water in a graduated measuring cylinder. Note the volume V_i of water in the cylinder. Tie the solid with a thread and lower the solid into the cylinder till it is fully immersed in water. Note the volume V_f of water. Volume of the solid will be $V_f - V_i$.

Q20. Define SIGNIFICANT FIGURES and write its rules to consider zero as significant figures?

Ans. All the accurately known digits and the first doubtful digit in a measurement are called significant figures." The accuracy of measured physical quantity depends upon

- the quality of the measuring instrument
- the experience of the observer
- the number of observations made

For example, a student measures the length of a book as 1.8cm using a meter rule. The numbers of significant figures in the measurement are two. The left digit 1 is the accurately known digit. While the digit 8 is the doubtful digit for which the student may not be sure.

Rules to find the significant digits in a measurement

i. Digits other than zero are always significant.

For Example

27 has 2 significant digits and 275 has 3 significant digits.

ii. Zeros between significant digits are also significant.

For Example

2705 has 4 significant digits.

iii. Final zero or zeros after decimal are significant.

For Example

275.00has 5 significant digits.

iv. Zeros used for spacing the decimal point are not significant. Here zeros are place holder only.

For Example

0.03 has 1 significant digit and 0.027 has 2 significant digits.

v. Whole number that end with one or more zeros without decimal point may or may not be significant depending upon the accuracy of instrument.

Example 1.4

Find the number of significant figures in each of the following values. Also express them in scientific notations.

(a) 100.8 s (b)0.00580 km(c)210.0g

Solution:

(a) In 100.8s all the four digits are significant. The zeros between the two significant figures 1 and 8 are significant. To write the quantity in scientific notation, we move the decimal point two places to the left, thus

$100.8\ s = 1.008 \times 10^2\ s$

(b) In 0.00580 km the first two zeros are not significant. They are used to space the decimal point. The digit 5, 8 and the final zero are significant. Thus there are three significant. In scientific notation, it can be written as 5.80×10^{-3} km.

(c) In 210.0g the final zero is significant since it comes after the decimal point. The zero between last zero and 1 is also significant because it comes between the significant figures. Thus the number of significant figures in this case are four. In scientific notation, it can be written as

$210.0\ g = 2.100 \times 10^2\ g$

MULTIPLE CHOICE

Encircle the correct answer from the given choices:

1. The number of base units in SI are
(a) 3 (b) 6
(c) 7 (d) 9

2. Which one of the following unit is not a derived unit
(a) pascal (b) kilogramme
(c) newton (d) watt

3. Amount of a substance in terms of numbers is measured in:
(a) gram (b) kilogramme
(c) newton (d) mole

4. An interval of 200 μs equivalent to :
(a) 0.2s (b) 0.02s
(c) 2×10^{-4}s (d) 2×10^{-6} s

5. Which one of the following is the smallest quantity.
(a) 0.01g (b) 2mg
(c) 100μg (d) 5000ng

6. Which instrument is most suitable to measure the internal diameter of a test tube:
(a) Metre rule (b) Vernier Calliper
(c) Measuring tap (d) Screw Gauge

7. A student claimed the diameter of a wire as 1.032 cm using Vernier callipers. Upto what extent do you agree with it.
(a) 1 cm (b) 1.0 cm
(c) 1.03 cm (d) 1.032 cm

8. A measuring cylinder is used to measure.
(a) mass (b) area
(c) volume (d) level of liquid

9. A student noted the thickness of glass sheet using screw gauge. On the main scale it reads 3 division. While 8th division on the circular scale coincides with index line. Its thickness is
(a) 3.8 cm (b) 3.08 mm
(c) 3.8 mm (d) 3.08 m

10. Significant figures in an expression are.
(a) all the digits
(b) all accurately known digits
(c) all the accurately known digits and the first doubtful digit
(d) all the accurately known digits and all the doubtful digits

11. 1 micro(μ)=
(a) 10^{-3} (b) 10^{-6}
(c) 10^{-12} (d) 10^{-2}

12. 1nm have meters.
(a) 10^{-3} m (b) 10^{-6} m
(c) 10^{-9}m (d) 10^{-10}m

13. In measurement 1.032 numbers of significant figure are
(a) 1 (b) 2
(c) 3 (d) 4

14. The unit of electric current is
(a) candela (b) metre
(c) second (d) Ampere

15. Andromeda is one of the billions of galaxies is known as
(a) star (b) asteroid
(c) pole (d) universe

16. The study of the structure and properties of atom is called
(a) Electricity (b) nuclear physics
(c) geo physics (d)atomic physics

17. The eleventh general conference was held in Paris
(a) 1959 (b) 1961
(c) 1660 (d) 1960

18. The unit of electric charge is
(a) Coulomb (b) ampere
(c) volt (d) joule

19. The least count of vernier calipers is
(a) .01mm (b)0.1mm
(c) .001mm (d) .01m

20. The least count of screw gauge is
(a) .01mm (b)0.1mm
(c) .001mm (d) .01m

21. A thimble of circular scale consists of equal division.
(a) 100 (b) 10
(c) 1000 (d) none of these

22. In screw gauge if zero of circular scale is behind the index line is called error.
(a) 100 (b)zero
(c) negative (d) positive

23. The number 275.00 consists of significant figures.
(a) 3 (b) 5
(c) 4 (d) 2

24. Science is that word which is derived by Latin word
(a) Scient (b) Scientis
(c) Scientia (d) Scincet

25. The number .00580 in scientific notation is
(a) 5.80×10^{5} (b) 5.80×10^{-4}
(c) 5.80×10^{-3} (d) $.5.80\times10^{-2}$

26. The unit of force is
(a) newton (b) m^3
(c) ms^{-2} (d) ms^{-1}

ANSWER KEY

1.	c	2.	b	3.	d	4.	c	5.	d
6.	b	7.	c	8.	c	9.	b	10.	c
11.	b	12.	c	13.	d	14.	d	15.	d
16.	d	17.	d	18.	a	19	b	20	a
21.	a	22.	d	23.	b	24.	c	25.	c
26.	a								

SHORT ANSWER QUESTIONS

Q1. Pick out the base units in the following
Ans. Joule, newton, kilogram, hertz, mole, ampere, metre, Kelvin, coulomb and watt.

Base Units	Derived Units
Kilogram	Joule
Mole	Newton

Ampere	Hertz
Meter	Coulomb
Kelvin	Watt

Q2. Find the base quantities involved in each of the following derived quantities:

(a) speed (b) volume (c) force (d) work

Ans.

(a) Speed:

It is distance covered per unit time . i.e.

$$V = \frac{\text{Distance}}{\text{Time}}$$

So in speed base quantities involved are length. i.e. distance and time

(b) Volume:

Volume = Length x height x width

= Length x length x length

So the base quantity in volume involved is length.

(c) Force:

We know that

$$F = ma. = \text{mass}\ \frac{\triangle v}{\triangle t} = m \times \frac{d}{t.t}$$

In this formula of force the base quantity is used is mass of object, length and time.

(d) Work:

We know that.

Work = F x distance

= ma x distance

$$= m\left(\frac{\Delta v}{\Delta t}\right)S$$

In this formula of work base quantity used is mass, and length (distance) and time.

Q3. Estimate your age in seconds.

Ans. Suppose the age of Student is 15 year

Age = 15 year

Age in month = 15 x 12 = 180 months.

Age in day = 180 x 30 = 5400 days

Age in hours = 5400 x 24 = 129600 hours

Age in minutes = 12960 x 60

7776000 minutes

Age in seconds is = 7776000 x 60 = 466560000 second

Q4. What role SI units have played in the development of science?

Ans. With the development of science and technology in the field of science the need for acceptable system of units was felt all over the world particularly to exchange scientific and technical information. So in 1960 international Bureau of weight and measurements were

decided to introduce worldwide system of measurements that is called system of measurements that is called international system of unit and is commonly written as SI.

Q5. What is meant by vernier constant?

Ans. The difference between one main scale division and one vernier scale division is called vernier constant or least count. i.e. 1 mm – 0.9 mm = 0.1 mm

Q6. What do you understand by the zero error of a measuring instrument?

Ans. In measuring instruments there may be systematic error, due to which a measurement may be less or greater than actual measurement.

Q7. Why is the use of zero error necessary in a measuring instrument?

Ans. Since zero error of instruments effect all the measurements, so it must be necessary we have to take the zero error in any measurement.

Q8. What is a stopwatch? What is the least count of a mechanical stopwatch you have used in the laboratories?

Ans. A stop watch is used to measure time interval of an event. The mechanical stop watch has least count 0.1 second.

Q9. Why do we need to measure extremely small interval of time?

Ans. To measure perfect accuracy we need to measure small interval of time.

Q10. How is precision related to the significant figures in a measured quantity?

Ans. In any measurement, greater the number of significant figures, greater is precision.

Q11. What do you know about Andromeda?

Ans. Andromeda is one of the billions of galaxies is known universe.

Q12. Name five prefixes commonly used.

Ans. Milli, micro, mega, kilo, nano, pico.

Q13. How can we round the number?

Ans. If the last digit is less than 5 then it is simple dropped for example 1.943. is rounded to 1.94.

i. If the last digit is greater than 5 then the digit on its left is increased by 1. For example 1.47 is rounded to 1.5

If the last digit is 5 then it is rounded to get nearest even number. For example 1.35 rounded to 1.4 and 1.45 is also rounded to 1.4

Q14. Identify the base quantity in the following:

(i) Speed (ii) Area (iii) Force (iv) Distance

Ans. Base quantity distance (length).

Q15. Identify the following as base or derived quantity:

Density, force, mass, speed, time, length, temperature and volume.

Ans. Base quantities are mass, time, length, temperature while derive quantities are density, force, speed and volume.

Q16. The Sun is one hundred and fifty million kilometers away from the Earth. Write this

(a) as an ordinary whole number.

(b) In scientific notation.

Ans. (a) 150,000,000
(b) 15×10^7
1.5×10^8

Q17. Write the number given below in scientific notation.
(a) 3000000000 (b) 6400000 m
(c) 0.00000000 16g (d) 0.0000548 s

Ans. (a) 3.0×10^9
(b) 6.4×10^6
(c) 1.6×10^{-9}
(d) 5.48×10^{-5}

Q18. Which one of the two instruments is more precise and why?
(a) Vernier Callipers
(b) Screw gauge

Ans. Screw gauge is more precise than vernier calipers because it measure hundred part of millimeter while vernier calipers measure ten parts of millimeter.

NUMERICAL PROBLEMS

Q1.1. Express the following quantities using prefixes.
(a) 5000 g (b) 2000 000 W
(c) 52×10^{-10} kg (d) 225×10^{-8} s

Solution

(a) 5000g
$= 5 \times 10^3$ g
= 5kg

(b) 2000, 000w
$= 2 \times 10^6$ w.
= 2mega watt, 10^6w=1Mw.
= 2MW.

(c) 52×10^{-10} kg
$= 5.2 \times 10^{-9}$ kg
$= 5.2 \times 10^{-6} \times 10^{-3}$ kg
:- 10^{-3}kg = 1g
$= 5.2 \times 10^{-6}$ g
:- 10^{-6}kg = 1µg
= 5.2x 1µg.
= 5.2µg

(d) 225×10^{-8} sec
2.25×10^{-6} sec 1µ sec = 10^{-6}sec
2.25 x µsec
=2.25 µsec

Q1.2 How do the prefixes micro, nano and pico relate to each other?

Solution

1 micro = 10^{-6}
1 nano = 10^{-9}
1 pico = 10^{-12}
10^{-3}micro = $10^{-6} \times 10^{-3}$
10^{-3}micro = 1nano
1 nano = 10^{-9}
10^{-3} nano = $10^{-9} \times 10^{-3}$
= 10^{-12}

So 10^{-3}nano = 1 pico

Q1.3 Your hair grow at the rate of 1mm per day. Find their growth rate in nm s^{-1}

Solution

Rate of hair growth = $\frac{1\text{mm}}{\text{day}}$

Growth rate in nms^{-1} = ?

1mm per day $= \frac{1mm}{day}$

1 day have seconds = 86400 s

1mm per day $= \frac{1mm}{86400s}$

1mm $= 10^{-3}$ m

$= \frac{1\times10^{-3}m}{86400s}$

$= \frac{1\times10^{-3}}{8.64\times10^{4}}$

$= \frac{1}{8.64}\times10^{-3}\times10^{-4}$

$= 0.1157\times10^{-7} ms^{-1}$

$= 11.57\times10^{-2}\times10^{-7} ms^{-1}$

$= 11.57\times10^{-9} ms^{-1}$

so hair growth rate in $nms^{-1} = 11.57 nms^{-1}$

Q1.4 Rewrite the following in standard form.

(a) 1168×10^{-27} (b) 32×10^{5}

(c) 725×10^{-5}kg (d) 0.02×10^{-8}

Solution

(a) 1168×10^{-27}

$= 1.168 \times 10^{-27} \times 10^{3}$

$= 1.168 \times 10^{-24}$

(b) 32×10^{5}

$= 3.2 \times 10^{5} \times 10$

$= 3.2 \times 10^{6}$

(c) 725×10^{-5} kg

$= 7.25 \times 10^{-5} \times 10^{2}$ kg 10^{-3} kg = 1g

$= 7.25$ g

(d) 0.02×10^{-8}

$= 2 \times 10^{-8} \times 10^{-2}$

$= 2\times10^{-10}$

Q1.5 Write the following quantities in standard form.

(a) 6400 km (b) 380 000km

(c) 300 000 000ms^{-} (d) seconds in a day

Solution

(a) 6400Km

$= 6.4 \times 10^{3}$ Km.

(b) 380000 Km

$= 38 \times 10^{4}$ Km

$= 3.8 \times 10^{+5}$ Km

(c) 300, 000, 000 ms^{-1}.

$= 3 \times 10^{8} ms^{-1}$.

(d) Seconds in day are = 86400 sec

$= 864 \times 10^{2}$ sec

$= 8.64 \times 10^{4}$ sec

Q1.6 On closing the jaws of a Vernier Calliper, zero of the vernier scale is on the right to its main scale such that 4th division of its vernier scale coincides with one of the main scale division. Find its zero error and zero correction.

Solution

Since the zero of vernier scale is on the right side of the main scale. So the error is positive and its correction will be negative.

Zero error of vernier is 4 x 0.01cm

= 0.04 cm

Correction will be = –0.04 cm

Q1.7 A screw gauge has 50 divisions on its circular scale. The pitch of the screw gauge is 0.5mm. What is its least count?

Solution

Division on circular scale = 50

pitch of screw gauge is 0.5mm

Least count = ?

$\text{Least Count} = \frac{pitch\ of\ screw\ guage}{division\ on\ circular\ scale}$

$= \frac{0.5}{50} = \frac{1}{100}$

= 0.01mm.

Least Count = 0.01mm

Or $= \frac{0.01}{10} cm$

$= 0.001 cm$.

Q1.8 Which of the following quantities have three significant figures?

(a) 3.0066m (b) 0.00309kg
(c) 5.05×10^{27}kg (d) 301.0 s

Solution

(a) 3.0066 m =
Its significant figures are = 5

(b) 0.00309 kg
Its significant figures are = 3

(c) 5.05×10^{-27} kg
Its significant figures are = 3.

(d) 30.10 sec
Its significant figures are = 4

So (b) and (c) have 3 significant figures.

Q1.9 What are the significant figures in the following measurements?

(a) 1.009m (b) 0.00450kg
(c) 1.66×10^{27}kg (d) 2001 s

Solution

(a) 1.009 m.
Significant figures are = 4

(b) 0.00450 Kg
Significant figures are = 3

(c) 1.66×10^{-27} kg
Significant figures are = 3

(d) 2001 see
Significant figures are = 4

Q1.10 A chocolate wrapper is 6.7 cm long and 5.4 cm wide. Calculate its area upto reasonable number of significant figures.

Solution

Length of chocolate wrapper = 6.7cm.
Width of chocolate wrapper = 5.4cm.
Area = ?

Solution

Area = Length × Width
= 6.7 x 5.4
= 36.18 cm^2
= 36 cm^2